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The Triple Challenge for Europe: The Economy, Climate Change and Governance

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The Triple Challenge for Europe: The Economy, Climate Change and Governance

Jan Fagerberg, Staffan Laestadius and Ben R. Martin

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Abstract

Europe is confronted by an intimidating triple challenge – economic stagnation, climate change, and a governance crisis. This paper demonstrates how the three challenges are closely inter-related, and discusses how they can be dealt with more effectively in order to arrive at a more economically secure, environmentally sustainable and well governed Europe. In particular, a return to economic growth cannot come at the expense of greater risk of irreversible climate change. Instead, what is required is a fundamental transformation of the economy to a new ‘green’ trajectory based on rapidly diminishing emission of greenhouse gases. This entails much greater emphasis on innovation in all its forms (not just technological). Following this path would mean turning Europe into a veritable laboratory for sustainable growth, environmentally as well as socially. The paper is based on a forthcoming book: Fagerberg, J., S. Laestadius and B. R. Martin eds. (2015) *The Triple Challenge for Europe: Economic Development, Climate Change and Governance*, Oxford University Press.

Keywords: Europe, European Union, triple challenge, economic stagnation, climate change, governance crisis, innovation policy, transformation process

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1. Introduction

This paper argues that Europe today is confronted by fundamental changes in its external environment as well as internally, giving rise to several daunting policy challenges, which, although also present in the rest of the world, are particularly severe in Europe. First, there is *the economic challenge* manifest in slow growth or even stagnation in many developed countries. This is related to various factors. One is the globalization of the world economy and the rise of new economic powers in Asia and elsewhere, posing a threat to the competitiveness of many national industries. A second is the extensive and long-lasting impact of the 2007-8 financial crisis and the measures taken to counter its effects. Economic stagnation has been especially pronounced in Europe, where it has led amongst other things to increased differences between rich and poor countries and to very high levels of unemployment (especially among the young) in parts of the continent. Austerity programmes currently underway in a number of European countries are unlikely to provide a satisfactory solution to these problems. Rather, as we shall argue, what is required is a continuous upgrading of skills, technologies and industrial structures in the countries concerned.

Second, there is *the challenge posed by the climate crisis*, the solution of which requires nothing less than a fundamental transformation from carbon-based growth to a new, sustainable economy. This may be technologically feasible but is nevertheless extraordinarily difficult to bring about as it challenges fundamental beliefs regarding the economy and society, not to mention powerful economic interests. Yet without a successful transformation to a sustainable economy, future generations will be in dire straits. Like the economic challenge, the climate challenge points to the need for long-term policies supporting the development of skills, innovation and structural change.

The third challenge concerns *the governance and policy crisis now facing Europe* and the difficulties this poses for policy making and implementation. A European Union that is struggling with dwindling popular support for its institutions, is finding it difficult to rally its citizens behind adequate responses to such long-term problems. This paper argues that a completely new policy stance is required, one that simultaneously addresses the challenges brought about by economic stagnation, by climate change, and by the governance crisis.

The structure of the paper is as follows. The two next sections focus on the economic challenge and the climate challenge, respectively. Section 2 shows that to revive the European economy, increase welfare and combat unemployment, economic growth is necessary. However, as section 3 demonstrates, this may easily come at the expense of the climate, with potentially adverse long-run consequences. Is there a way out of this dilemma? Section 4 discusses the possibilities for future economic growth in Europe with particular emphasis on the need for

sustainability, while section 5 considers the challenges for policy and governance. The final section sets out the conclusions with respect to how these challenges can be dealt with more effectively in order to arrive at a more economically secure, environmentally sustainable and well governed Europe.

2. The Economic Challenge for Europe

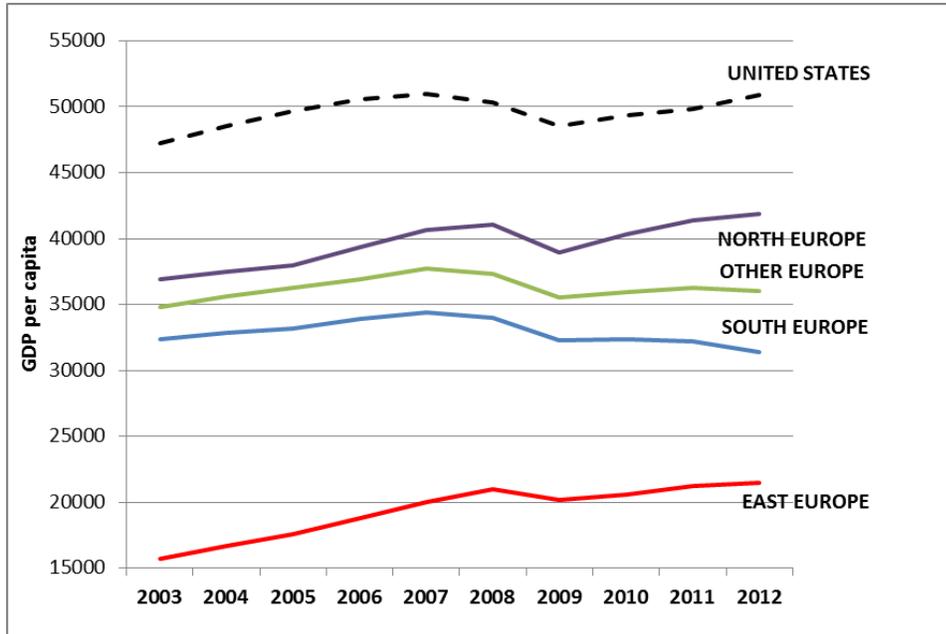
Over the longer term, European economic integration has delivered very substantial benefits to Europe's citizens. For example, during the first two or three decades of integration efforts in (Western) Europe the economy grew very fast, and the gap in productivity and income *vis-à-vis* the world's technologically and economically leading country, the United States, was considerably reduced (Abramovitz, 1994 a & b). The diffusion of technologies and innovations, including ways to organize business and consumption patterns that were pioneered in the US before the war but only applied in Europe on a major scale from the 1950s onwards, played an important role in the rapid catch-up process by Western European countries during the decades that followed. The emerging economic integration of Europe, by providing a sufficiently large and growing market, was instrumental in supporting the growth of the new industries of the time.

The European Union has also been notably successful in supporting transitions from authoritarian regimes to democracy in large parts of Europe. This happened first from the mid-1970s onwards when the fascist dictatorships in Southern Europe were swept away following popular uprisings, and once more - and on a much larger scale - in the 1990s onwards following the disintegration of the former Soviet Union. The gradual integration of the countries in Eastern Europe, followed by substantial inflows of investment from the rest of Europe, led to very rapid growth in the new member countries and markedly reduced differences in productivity and income across Europe as a whole (Fagerberg and Verspagen 2015).

Around the turn of the millennium, several European initiatives were taken to sustain the positive dynamics of the previous decades in the expectation that this would lead to a further narrowing of the gap in GDP per capita between the US and Europe. For example, at the EU summits in Lisbon and Barcelona in 2000 and 2002, Member States agreed on the goal of making Europe "the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion" by increasing R&D investments (as a share of GDP) to a level superior to that of the USA by the

end of the decade.¹ Moreover, a common European currency, the Euro, was introduced in 2002 as part of the strategy to further deepen European integration and spur economic growth.

Figure 1. GDP per capita, constant USD, 2003-2012



Note. Authors' calculations of population-weighted GDP per capita, in constant US\$ (PPP-adjusted) at 2013 price levels, for selected country groups, based on data from the World Bank (<http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD> and <http://data.worldbank.org/indicator/SP.POP.TOTL>), accessed on 21.9.2014

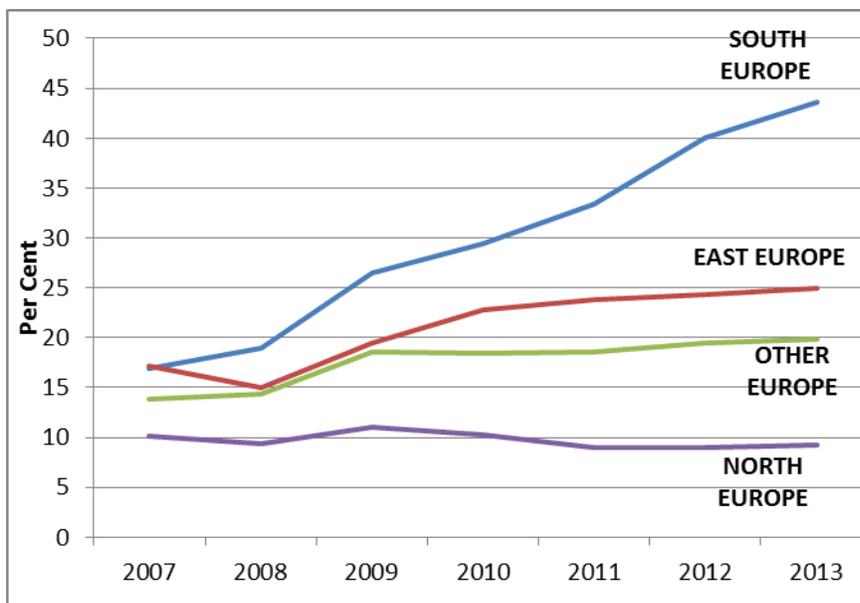
To what extent did European policy makers succeed in their aims? Figure 1 traces the development of GDP per capita from 2003 onwards for four groups of European countries (and for comparison the United States), measured in constant, purchasing power parity (PPP) adjusted, US dollars.² As the figure shows there is little evidence of Europe catching up with the US during this period. In fact, in 2012 GDP per capita in the European Union was 65% of the US level, exactly the same as ten years earlier. Among the European countries, only the new members from the East of Europe managed to substantially reduce the productivity gap *with*

¹ See http://www.consilium.europa.eu/en/uedocs/cms_data/docs/pressdata/en/ec/00100-r1.en0.htm (accessed on 22 January 2015). However, with the exception of a few countries, little progress has been made towards achieving this aim.

² These country groups are mostly self-explanatory, except perhaps for the residual category of "other Europe", which consists of countries in the Middle and West of Europe (Belgium, France, UK, Ireland and some smaller countries not included elsewhere). Germany is included in the "North" together with the Nordic EU-member countries and the Netherlands. The Southern countries are Greece, Italy, Portugal and Spain, while the Eastern group consists of the eleven member countries formerly part of, or dominated by, the Soviet Union.

respect to the US, rising from 33 % to 42% of the US level between 2003 and 2008, after which the catch-up of Eastern Europe came to an abrupt halt.³ The Northern European countries recorded a slight increase over the same period, from 78% in 2003 to 82% in 2008, with no gains thereafter. However, in Southern Europe GDP per capita dropped from 69 % to 62% of the US level between 2003 and 2012, and the average GDP per capita level there in 2012 was approximately ten per cent below the pre-crisis level (see Figure 1). Thus, rather than the convergence in GDP per capita that characterized Europe during the previous decade, the years after 2007-8 have witnessed a process of *divergence*, with several countries, particularly in the Southern part of the continent, falling further behind economically.

Figure 2. Youth Unemployment (20-24 years)



Note. Authors' calculations of population-weighted unemployment rates for selected country groups based on data from Eurostat ([http://appsso.eurostat.ec.europa.eu/ \(yth_empl_090\)](http://appsso.eurostat.ec.europa.eu/ (yth_empl_090))), accessed on 21.9.2014) for unemployment and The World Bank (<http://data.worldbank.org/indicator/SP.POP.TOTL>), accessed on 21.9.2014) for population

Should we be concerned about these developments? Yes - and to see why, consider Figure 2, which shows unemployment rates for young adults aged 20-24 in different parts of Europe since the crisis struck (see also Landesmann 2015). The slow growth and increasing divergence

³ By 2012, only about half of the Eastern member countries had managed to recover to pre-crisis levels of GDP per capita. The somewhat better performance of Eastern Europe as group (see Figure 1) owes much to Poland, the most populous country in the region, which has exhibited a markedly better performance than other European economies after the financial crisis struck.

that characterize the European economy are clearly mirrored in Figure 2: apart from in Northern Europe,⁴ youth unemployment has been on the increase everywhere. In Southern Europe, the level of youth unemployment has tripled compared to the situation before the financial crisis, and currently close to half of all young adults seeking a job there cannot find one. In Eastern Europe, the level of youth unemployment has doubled over the same period, and the situation is also worrying in other countries such as France. This is, of course, just the opposite of the goal stated more than a decade ago of “sustainable economic growth with more and better jobs and greater social cohesion”. If this situation is not reversed quickly, large numbers of young people in Europe risk being permanently marginalized – i.e. unemployed and living in relative poverty – the social, economic and political consequences of which are likely to be highly detrimental to Europe’s future.

Why is Europe’s growth performance so disappointing? Economic theory tells us that growth in GDP per capita is to a considerable extent brought about by innovation and diffusion of technology (Fagerberg 1994; Verspagen 2004; Keller 2004). This process also opens up the possibility for actors who are not at the innovation frontier to tap into the growth potential of innovation by exploiting the scope for diffusion (or ‘spill-overs’). According to economic historians such as Gerschenkron (1962) and Abramovitz (1986), the further behind a country lies, the larger the potential for “catch-up” in productivity *vis-à-vis* the technologically leading nations. Hence, from this perspective one might have expected the countries in the East and South of Europe to have grown substantially faster than the richer countries in the Northern part of the continent, the opposite of what has been observed recently. However, the leading theoretician on catch-up processes, Moses Abramovitz, was at pains to stress the difference between a *potential* for catch up and its *realization* (Abramovitz, 1994a & b). The latter, he argued, also depends on how favourable the external regional environment is, the nature of the technological and structural changes that occur globally, and how well placed (or adapted) a country is to profit from these changes. Hence, to understand the reasons behind the present stagnation and divergence in Europe, it is necessary to examine the factors influencing these developments in more detail.

The economic changes that have taken place in Europe during the last two or three decades have occurred within an international context characterized by globalization. The ICT revolution, combined with innovations in transport technology, provided the basis for the development of new business models based on the coordination of activities at a global scale, thereby separating the different stages of production in order to exploit the various advantages that different locations across the globe may possess. The gradual inclusion of China in the global

⁴ Note that the favourable trend for Northern Europe is caused solely by developments in Germany. Youth unemployment increased in the four other countries included in this category.

capitalist economy, adding hundreds of millions of lower-paid manufacturing workers to the global labour pool, and effectively transforming China into “the factory of the world”, provided a substantial boost to this process. As a result, the Chinese economy has grown very fast while similar – although somewhat less spectacular – developments have taken place in other developing nations (Fagerberg and Verspagen 2015). This process, while hugely beneficial for the hundreds of millions lifted out of poverty (and for the global economy as a whole), also poses a challenge, however, because it tends to undermine the competitive position of established industries throughout the developed world, especially in low skill, labour-intensive manufacturing processes. Indeed, it even affects newer industries such as those in ‘green’ sectors (Schmitz and Lema 2015) and in ICT sectors (Long 2015). However, globalization also offers new opportunities for exports of advanced products to the rapidly growing markets in China and elsewhere, as countries such as Germany and Sweden have recognized and been keen to exploit. The evidence (Fagerberg and Verspagen 2015, Landesmann 2015) suggests that the effects of globalization on the growth performance of different parts of Europe have been very uneven. While the advanced economies in the North of Europe have to a certain extent managed to adapt to the changing competitive conditions and taken advantage of the opportunities opened up by globalization, substantially increasing their exports as a percentage of GDP, countries in the Southern part of the continent (and some in the East) have generally failed to do so. Indeed, their low-tech manufacturing sectors appear to have been particularly vulnerable to the consequences of globalization. Thus, they have become losers in the globalization process.

Europe’s growth performance is also influenced by how European integration has developed, and by the strategies pursued by leading economies in the Union, especially Germany. The introduction of the Euro in 2002 meant that the economies of the Euro-zone became more interdependent. A natural consequence of this might well have been a greater degree of coordination of economic policies among the participating countries. But the Euro-zone countries continued to shape their economic policies largely based on domestic considerations, effectively disregarding the consequences for other countries and the wider Euro-zone. This clearly illustrates the governance and policy challenge confronting Europe. For example, Germany, following the costly re-unification with former East Germany, decided to restrain growth in wages and domestic demand in order to boost the competitiveness of its industry and to run a trade surplus with the rest of the world. However, this policy implied that other, less competitive members of the Euro-zone, with less scope for growing through increasing exports, would have to practice austerity as well if increasing trade deficits were to be avoided, with rising unemployment an almost inevitable consequence. Initially, several countries in the South shied away from austerity, leading to increasing deficits and rising foreign indebtedness (Fagerberg and Verspagen 2015, Landesmann 2015), a situation which clearly was not

sustainable. However, eventually the financial crisis brought governments in different parts of Europe together under the umbrella of austerity, leading to slow growth, rising unemployment (especially in the South) and increasing divergence in the Union as whole.

The slow growth and increasing divergence in Europe can therefore be directly linked to the policies currently pursued by the European Union in general and its leading country, Germany, in particular. The hope of policy-makers is – as was initially the case in the 1930s as well – that austerity eventually will make the European economy more “healthy” and breed the conditions for recovery. This overlooks the fact that the primary reason for the current malaise is not market imperfections that can be quickly eliminated (although financial recklessness in the lead up to 2007 clearly played a significant part), but deep-rooted differences in the capacities of different European countries to adapt to – and profit from – ongoing changes to the global economy . Austerity will most probably not lead to improvements in this respect but rather make the situation worse by creating a hostile climate in which much needed innovative initiatives stand little chance of succeeding. A new policy stance is therefore required.

3. Europe and the Climate Challenge

As elsewhere in the world, Europe also faces the looming threat of climate change. The effects of greenhouse gas (GHG) emissions are slowly developing, global in character and often far from easy to identify and distinguish from natural variations. Indeed, until recently there were significant differences in opinion among scientists as to the existence of climate change, the consequences of GHG emissions, and the role of humankind in the processes taking place. Now there seems to be a growing consensus among analysts that the globe is heading towards a 3-6 °C warmer Earth than a century ago, and that this global warming is to a large extent caused by GHG emissions with their origin primarily in human activities (IEA, 2011; IEA, 2013b; IPCC, 2013a,b & 2014; World Bank 2012 & 2013). The concern is that, if the present emissions of GHGs in the atmosphere are not significantly reduced over the decades ahead, the consequences for human life may be dire. Large parts of the Earth may become either too dry (or too hot) to live in, or be drowned by the sea, the level of which may rise by up to one meter during this century. Moreover, all parts of the world are likely to be affected by more extreme weather conditions (IPCC, 2012; World Bank, 2012 & 2013).

Even though there is growing consensus among scientists on climate change, political action on how to adapt to or mitigate climate change has been lagging. The failure hitherto to reach any substantial agreements within the United Nations Framework Convention on Climate Change (UNFCCC), which started in 1992, is a prime illustration of that. There appear to be many contributing factors:

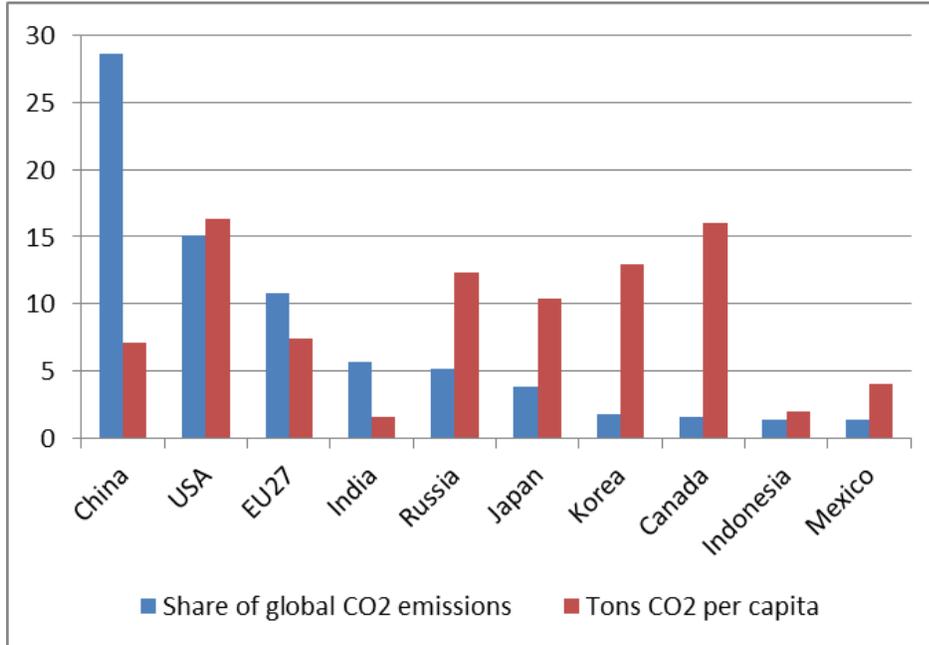
- Fossil fuels are the dominant sources of energy in many countries. Most people have no vision of how a decent life or a functional economy can be achieved without burning fossil

fuels. This “addiction to carbon” (Laestadius 2015) is a major factor behind the reluctance towards shifting the economy in a sustainable direction, and it is reinforced by resistance to change from dominant incumbent actors such as energy firms (Geels 2015, Lauber and Jacobsson 2015).

- Linked to this is a reluctance among the public to engage in substantial behavioural change (including making sacrifices such as international travel), especially when the beneficiaries of such changes are remote either geographically (e.g., living in low-lying parts of Bangladesh) or temporally (i.e., future generations).
- Fossil fuels also provide significant employment, income and profits. Many regions are heavily dependent on mining of coal or lignite, and the automotive sector – still very reliant on fossil fuels – is, not the least in Europe, a strong generator of employment, both directly and indirectly.
- Fossil fuels are still the cheapest source of energy in many countries. Yet they continue to be directly or indirectly subsidized in many instances (IEA, 2011; IEA, 2013b). Many governments are nervous about the political consequences of higher energy prices, and not just in poorer economies.
- Businesses and politicians alike are concerned that too restrictive policies on the use of fossil fuels in their own region or country may allow firms in countries with more lax regulations to capture market share and employment.
- 200 years of CO₂ emissions have contributed significantly to the wealth of the developed part of the world. The developing countries of today naturally want to achieve similar benefits to those reaped by the early movers and have hitherto – in the absence of cheap, sustainable alternatives – been understandably reluctant to share the burden of reducing CO₂ emissions. This continues to be a dilemma, as evidenced by the UNFCCC negotiations in Lima in December 2014.

Europe is in the midst of this. As Figure 3⁵ shows, Europe is the third largest CO₂ emitter in the world, although on a per capita basis European emissions are not particularly high (similar to those in China but far lower than in the US and other developed economies).

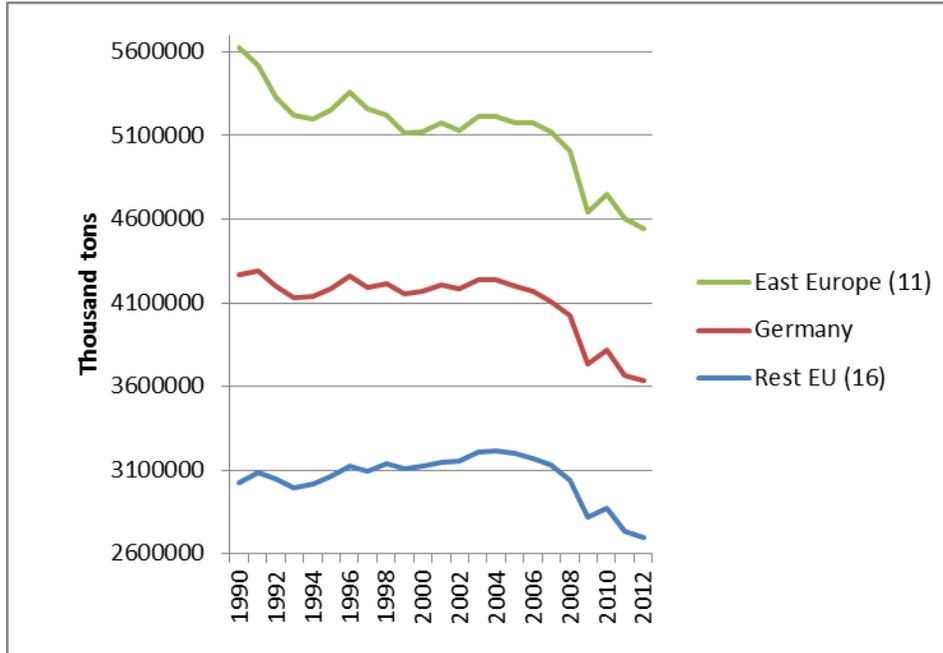
⁵ Note that the figure shows domestic emittances of CO₂. However, a country may also be seen as contributing to global CO₂ emissions through its imports. For example, in the case of Sweden the CO₂ emitted to allow for its import has been shown to be almost twice as large as the country’s domestic emissions ([source?](#)). Thus, from this perspective the Chinese emissions may be seen strongly related to its exports of manufacturing products to the rest of the world.

Figure 3. Largest global CO2 emitters, 2012

Note: Authors' calculations based data from on the Edgar database (<http://edgar.jrc.ec.europa.eu/>, accessed on 21.9.2014)

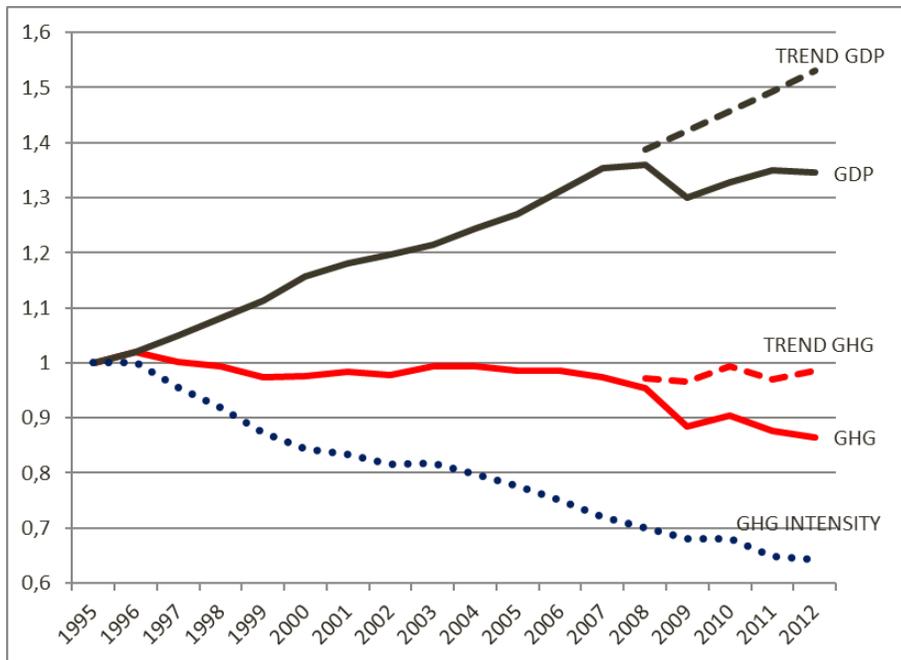
However, the fact that other countries emit more per capita than Europe, does not mean that Europeans can sit back and wait for other countries to reduce their emissions. It is the absolute amount of greenhouse-gases in the atmosphere that matters for the climate, and the world is rapidly approaching the limit for how much greenhouse gases the atmosphere can absorb if damaging climate-related consequences are to be avoided (by staying within the 2°C target). According to the IPCC, in order to confine temperature rises to 2°C, global GHG emissions have to be reduced substantially by 2050, and almost completely eliminated by the end of the century (IPCC, 2014). To achieve these exceedingly demanding goals, use of fossil fuels has to be reduced by approximately 3-4% annually for the rest of this century (Smil, 2010). It would seem only reasonable that the developed part of the world, which has benefitted from previous emissions, should shoulder the largest burden.

European politicians pride themselves on having already substantially reduced greenhouse-gas emissions and hence for being on broadly the right track (European Council, 2014). But is this correct? To explore this, Figure 4 traces the development of European GHG emissions from 1990 onwards.

Figure 4. GHG emissions, EU28, 1990-2012

Note: Authors' calculations based on data from Eurostat (http://appsso.eurostat.ec.europa.eu/env_air_gge), accessed on 5.11.2014)

In Figure 4, total EU emissions are divided into three categories: Eastern Europe, Germany (including the former GDR) and the rest of Europe. What the figure shows is that, for Europe as a whole, there was a reduction in emissions in the early 1990s, but this can be almost entirely explained by the rapid changes that took place (including the closure of inefficient plants) in the previously socialist countries in the East. For the rest of Europe, emissions were essentially stable until the outbreak of the financial crisis. The question that this then raises is whether the more recent decline in emissions represents a shift towards a new, more sustainable path, or whether it is mainly a consequence of the crisis, and hence is likely to be reversed should the economy recover.

Figure 5. GDP and GHG emissions, EU28, 1995-2012

Note: Authors' calculations based on data from Eurostat ([http://appsso.eurostat.ec.europa.eu/\[nama_10_gdp\]](http://appsso.eurostat.ec.europa.eu/[nama_10_gdp])) and [[env_air_gge](http://appsso.eurostat.ec.europa.eu/[env_air_gge])], accessed on 5.11.2014). Trend-GDP is a continuation of the 1995-2007 trend for GDP, while Trend-GHG is what the emissions would have been in that case (with actual GHG intensity).

To investigate this, Figure 5 includes data on GHG emissions and growth of GDP for the European Union as a whole between 1995 and 2012. It reveals that the GHG intensity (i.e. GHG emissions per unit of output) has declined steadily, as it has in the US (Nordhaus 2013). But until shortly before the financial crisis, this decline was not enough to reduce Europe's emissions. Moreover, as the figure shows, had growth continued at the same pace as before the crisis, emissions would have stayed roughly constant. Thus, the recent decline in emissions does not reflect a change towards a more sustainable path for the European economy, but is mainly a reflection of continuing economic stagnation.

This raises serious questions about Europe's ability to cope with these challenges. If European GHG emissions are to be reduced to a negligible level towards the end of the current century, as European policy-makers several times have agreed to, they must be reduced by approximately 3-4 % every year on average. Alternatively, if the GHG intensity continues to decline, as in the past, by around 2.5 % per year, this means that Europe's GDP would have to shrink every year in order to reach the target. Hence, a revival of the economy, which is needed to reduce unemployment and increase welfare, appears to be in direct conflict with the need to

combat climate change. Or to put it differently, to realize both objectives, the European economy has to be shifted to a completely new trajectory when it comes to the emission of greenhouse gases. For example, to allow for economic growth of 1.5 % per year for Europe as a whole, the annual decline in the GHG intensity needs to double, to around 5% per year. This is a truly formidable challenge. This will require a fundamental transformation of the European economy (. Activities and technologies that (directly or indirectly) emit GHGs will have to be phased out and substituted with sustainable alternatives. Sometimes this might result in new fuels being substituted for old ones (for cars, for example), but it may also involve more radical changes. Not least, significant energy savings will be necessary (IEA, 2013a & b). Creating the conditions, incentives and acceptance for this will require innovative policies.

Are there signs of such a transformation happening? After all, the policy challenge from climate change has been on the agenda for quite some time, and ambitious goals have been announced and new policy instruments created, notably the establishment a decade ago of a European market for GHG emission (the ETS – see Begg 2015). However, the ETS has completely failed in terms of creating a price-level for GHG emissions that would stimulate a transition towards increased sustainability. As is argued by Laestadius (2015), CO₂ prices will have to increase to around €40/ton or more in order to contribute to this transformation. Yet throughout 2014 they only sporadically exceeded €7.50/ton.

In October 2014, EU leaders met to consider European policies on climate change and agreed to reduce GHG emissions by 40% (compared to the 1990 level) by 2030 (European Council, 2014). If one takes into account that half of this has been achieved already, as explained above, this agreement implies an annual 1.8 % reduction in emissions between 2014 and 2030, about half the annual reduction needed to reach the long-term target that both the European Council and the European Parliament agreed to five years earlier. Hence, current EU leaders would seem to have ducked their responsibility, tacitly opting to leave most of the required efforts to future generations, by which time the task, according to IPCC analyses, will have become much harder (and the costs much higher).

4. Is (sustainable) growth possible?

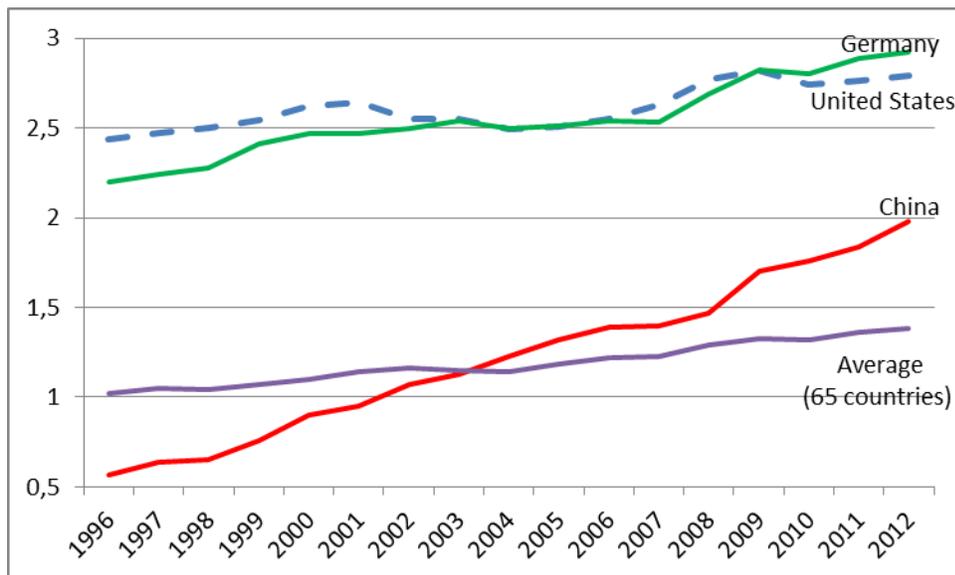
The climate challenge and the economic challenge are intimately interrelated.⁶ Without growth, greenhouse gas emissions may continue to decline, although almost certainly not at the pace necessary for their elimination by the end of the present century. But employment would undoubtedly continue to suffer. A return to the type of growth that prevailed before the

⁶ The interrelated nature of these challenges, obvious at it may seem, has apparently not yet penetrated EU policy thinking to any great extent. For example, in the conclusions from the European Council meeting of October 2014 (European Council, 2014), climate change and stagnation are both highlighted, but there is no mention of their interrelated nature.

financial crisis, on the other hand, might be good for employment but certainly not for the climate, as emissions would continue at unsustainably high levels. Is there a way out of this dilemma?

As a start it may be noted that economic growth does not necessarily mean doing more of the same. It can also mean getting more out of a given level of resources by doing things in a smarter way than before – that is, by innovation. Some are sceptical with regard to the potential of future innovation. But are there really reasons to believe that humankind is less capable of coming up with smart solutions than, say, fifty or hundred years ago? We believe the answer to this question is a clear ‘No’. Smart solutions, or innovations, typically mean combining different sources of information, knowledge and other resources in a novel way⁷, for which education is a great advantage (if not a must). Never have levels of education been as high as they are today. The same holds for the share of global economic resources used in searching for new and better ways of doing things. As Figure 6 shows, between 1996 and 2012, the share of GDP devoted to R&D increased by one third globally, and in China R&D expenditure as a percentage of GDP almost tripled over the same period to around 2 percent.

Figure 6. R&D as share of GDP, 1996-2012



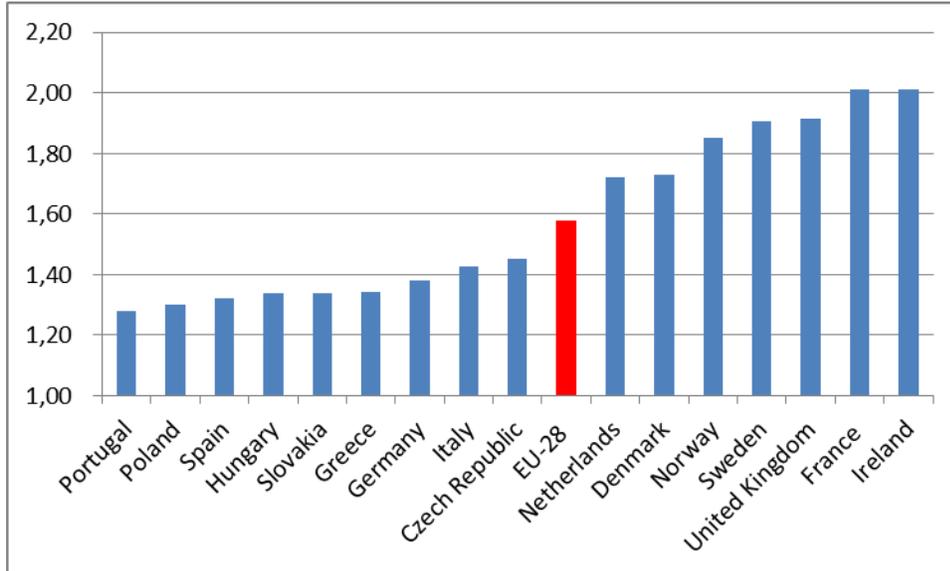
Note: Authors' calculations based on data from UNESCO (<http://data.uis.unesco.org/>) downloaded on 14 December 2014

⁷ Schumpeter, who is generally regarded as the founding father of the field of innovation studies, frequently used the term 'new combinations' instead of 'innovation' in his early work.

Nevertheless, as Robert Gordon (2012) has argued, even if technological progress continues unfettered over the remaining part of the 21st Century, there may well be various countervailing factors – what he calls “headwinds” – resulting in substantially slower growth in income (or GDP per capita). He points specifically to demography (and an aging population), reduced scope for increasing the qualifications of the labour force (through investments in education), globalization, increasing inequality (which he identifies as arguably the most important ‘headwind’), climate change, and the large public and private debts that need to be reduced. According to Gordon, the joint effect of these “headwinds” may well be to restrict future growth of GDP per capita in the United States to almost zero.

However, what (perhaps) holds for the US does not necessarily hold for the world as a whole. For example, as we pointed out above, countries at a lower level of development can gain a lot by exploiting technologies already in place in technologically more advanced nations. Moreover, an aging population is clearly not a problem in Africa, home to some of the fastest-growing countries in recent years. Furthermore, as Gordon points out, exploiting the potential for immigration – as the USA has done so successfully in the past – may go a long way to mitigate the potentially negative effects on economic growth of an aging population, in the US as well as elsewhere. Similarly, average education levels are still low in large parts of the world, so continuing investments in education should continue to bring large pay-offs. Globalization is not just a challenge but also an opportunity. Indeed, the rapid economic growth witnessed in large parts of the developing world in recent years has much to do with exploiting the opportunities offered by globalization. Inequality may well be a problem, but again there are substantial differences between countries in this respect, with inequality being much higher in the US than in Europe (Cingano, 2014; Piketty, 2014). Moreover, this is not an exogenous factor but something politics can influence.

How do each of these factors influence growth prospects in the European case? First, as pointed out above, GDP per capita in Europe is still just two thirds of that in the US, so there should be plenty of scope for catching up and hence for faster growth than in the US. Moreover, the differences in levels of economic development are much larger within Europe than between US states (Fagerberg et al., 2014), which means that there should be even greater scope for growth in poorer EU Member States, particularly in Eastern Europe. The issue of declining and aging populations, emphasized by Gordon, clearly represents a challenge, with only a handful of European countries currently having fertility rates sufficient to ensure a constant population (Figure 7). This challenge is especially evident in Southern Europe (Portugal, Spain and Greece), in other words, the very same countries that have suffered most in the aftermath of the financial crisis, as well as in some Eastern European countries (with Poland being the most important case).

Figure 7. Fertility rate (live births per woman), selected countries, 2012

Note: Authors' calculations based on data from data from Eurostat

(http://ec.europa.eu/eurostat/statistics-explained/index.php/Fertility_statistics), accessed on 15 December 2014.

Yet, as with several other challenges, this is something policy can influence, for example by creating favourable conditions for families with children, and allowing for more integration of young, entrepreneurial job-seekers from countries outside the EU, of which there appears to be an abundant supply. The growing anti-immigration sentiments in several European countries are both backward-looking and counter-productive; problems with integration notwithstanding, immigration is conducive to Europe's economic future, not a threat. Moreover, under current conditions an aging population would not seem to be a fundamental problem as long as 25-50% of the young population is unemployed.

Furthermore, while education levels are high in large parts of Europe, particularly in the North, average education levels in the South of Europe continue to lag substantially behind other European countries. Investing in education there, including the education of the current adult population who will continue to dominate the labour force for some time to come, may prove to be an essential element in a long-term policy for reviving the depressed economies in this part of Europe, not least in terms of leaving them better equipped to exploit opportunities opened up by globalization and European economic integration, opportunities which - as was pointed out earlier - they have largely failed to address so far. Finally, while the distribution of income generally is more equitable in Europe than elsewhere, Southern Europe again

represents an exception.⁸ Thus, a policy aimed at reviving these economies may need to pay particular attention to the distributional aspects of economic development.

Why has Europe been so slow in recovering from economic depression? We don't think this can be explained solely or even mainly in terms of less scope for innovation, or indeed "headwinds" of the type emphasized by Gordon. It also has to do with important weaknesses in the construction of the EU. The major problem has been the creation of a monetary union for countries with very different characteristics and economic dynamics, and without any effective policy coordination and the necessary mechanisms for mitigating problems that may occur either as a result of the diversity of the participating countries or due to external shocks. Hence, the entire Union was singularly ill-prepared for stormy weather, something that became all too apparent when the financial crisis struck in 2007-08. As Begg (2015) has pointed out, the economic levers available to the EU are very limited indeed. Worse still, the adoption of the common currency prevented the most crisis-ridden countries in Southern Europe from dealing as effectively with that crisis as they might otherwise have done. Instead, their governments were forced by the governing bodies of the EU and IMF to practice stringent austerity, with economic decline, higher unemployment (especially among the young) and rising inequality the almost inevitable consequences. It would seem that the European Union has dropped all aspirations of becoming "the most competitive and dynamic knowledge-based economy in the world" and instead, under the influence of its largest and most powerful member country, Germany, turned more into a union for stagnation.

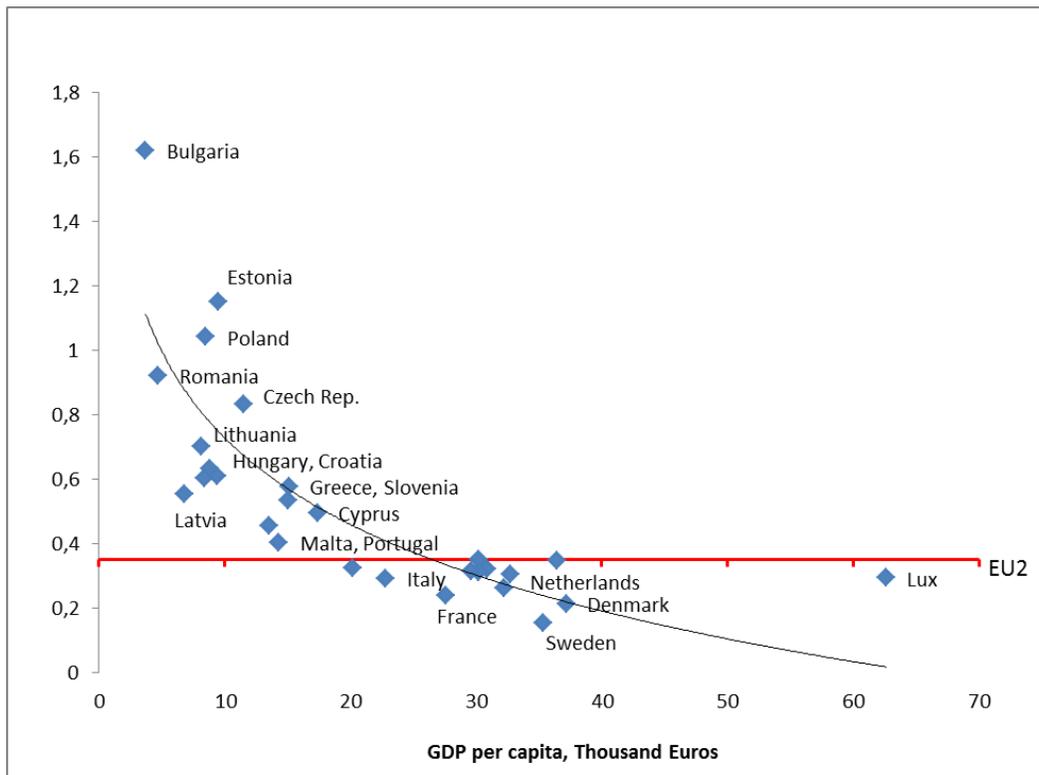
The German economic model, exploiting demand abroad rather than generating it at home (Fagerberg and Verspagen 2015), is based on the country's industrial strength and competitiveness. However, not all countries in the world can have an export surplus. Hence, what may work for a single country does not necessarily work for the global economy, and arguably not for an entity as large and heterogeneous as Europe, either. A radically different policy stance is required if Europe is to escape the current stagnation and its extensive social and economic consequences. As pointed out above, simply pumping up demand would quickly come into conflict with climate concerns and hence not be sustainable. Therefore a policy aiming at faster growth in Europe in order to increase employment and welfare must simultaneously speed up the transformation to a sustainable economy. The best way to achieve this is to target innovation, diffusion of new technology and, not the least, transformative investments in areas such as energy supply and distribution, increased energy efficiency, public transport, infrastructure for cars driven by electricity and fuel cells, and so on. Many of these investments in the energy sector, for example, would be necessary anyway (ECF, 2013) but undertaking them sooner rather than later (and using reduced GHG emissions as a yardstick in

⁸ See <http://www.oecd.org/social/income-distribution-database.htm> (accessed on 15 December 2014).

the selection process) may accelerate the transformation while at the same time reviving growth. Such a policy stance has to take into account the fact that the economies of Europe are very different, so there is no point in just mimicking the same policy, whether patterned on German experience or that of some other country, everywhere. One size does *not* fit all. Rather, what needs to be done is to identify the factors that prevent the various economies from growing and then addressing these factors head on.

Moreover, while such transformative investments are needed in all member countries, it is natural to place the emphasis on those countries that have further to go with respect to achieving sustainability. As Figure 8 shows, the countries most in need of transforming their economies in the direction of sustainability are poorer member countries in the East and to some extent the South (which are also in general the ones most adversely affected by the current stagnation). Thus, a programme for transformative investment based on these principles would not only be good for climate change and economic growth generally, but also deliver growth where it is most needed, thereby contributing to improved social cohesion in the Union as a whole.

Figure 8. GHG intensity and GDP per capita, EU28, 2012



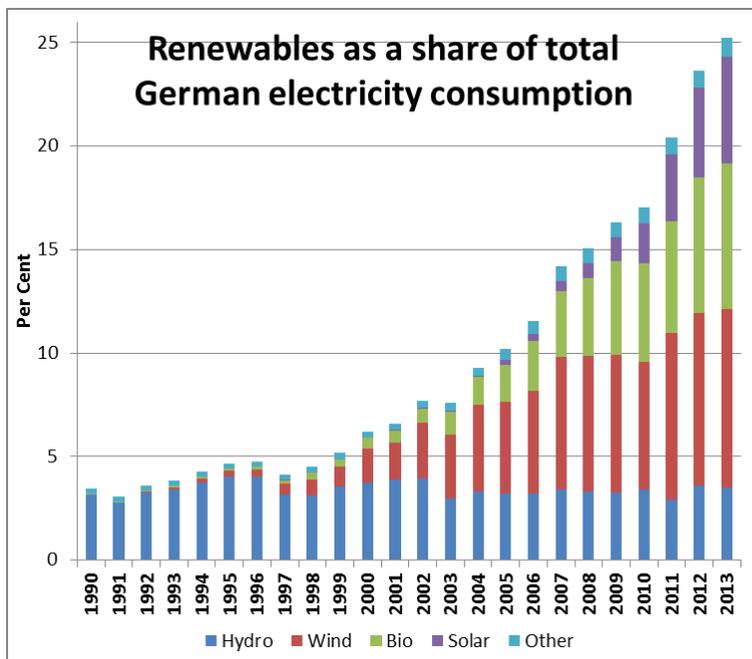
Note: Authors' calculations based on data from Eurostat ([http://appsso.eurostat.ec.europa.eu/\[nama_aux_gph\]](http://appsso.eurostat.ec.europa.eu/[nama_aux_gph])), accessed on 1.9.2014, and [[env_air_gge](http://appsso.eurostat.ec.europa.eu/[env_air_gge])], accessed on 5.11.2014)

A neglected issue in the frequent analyses of the European crisis concerns the extent to which the difficulties in increasing European investments, which still are 8% below the 2008 level, are related to “climate change expectations”. Significant parts of European industry know that things have to change and that transformative investments are needed. But the necessary conditions for that to happen are not yet in place. Arguably, instead of policies for general economic stimulation, policies must be strongly selective, promoting green industries and green consumption (Laestadius 2015).

Boosting Europe’s economy and its transition to a sustainable ‘green’ economy through transformative investments should be seen as a core element of European policy for innovation and growth. Innovation is not, as sometimes presented, primarily about creating new ideas that may (or may not) have profound effects sometime in the distant future. That is the role of research, which, although important, is not the same as innovation. Rather innovation is about trying out promising new solutions and ways of doing things, learning from the experience and on this basis improving the technologies in question . Hence, a good innovation policy is one that also promotes diffusion, use, learning and continuous improvement. An excellent example of such a policy is the German “Energiewende” (see Box 1). The policy approach advocated here for Europe falls squarely within such a framework.

Box 1 Germany's transition to sustainable electricity production – the Energiewende

One of the most remarkable achievements of any European country when it comes to transforming its economy in a sustainable direction is provided by Germany. Its “Energiewende” – literally energy transition – had its origins in the environmental and anti-nuclear movements of the 1970s and 1980s (e.g., the Green party), which received a large boost after the Chernobyl disaster in 1986. Renewable energy was seen as critical for phasing out nuclear generators, and the first national scheme requiring utilities to purchase renewable power from private sources



at a fixed rate (so-called ‘feed-in tariff’) was adopted by parliament in 1990. The coalition between Social Democrats and Greens that came to power in 1998 continued and expanded these policies, which they saw as essential for developing a dynamic capital-goods sector for renewables in Germany and bringing down the costs of renewable energy production. The feed-in tariffs were set at different levels for different technologies (e.g. solar, bio, on-shore wind, off-shore wind etc.) depending on how far these had

come with respect to being commercially viable. It is thus an example of a policy supporting technological development on a broad front, allowing different technologies time to deliver on their promise, thus avoiding premature lock-in to a specific technology at a too early stage.

The process acquired substantial momentum after the turn of the millennium, as the Figure shows, and growth has been especially rapid in recent years. A substantial German capital-goods industry also developed and costs declined as envisaged. However, as a result of its success the policy has also become more controversial. For example, it has come under fire from electricity utilities (with huge sunk costs in coal-based plants which are threatened by the surge in renewables) and politicians from coal-producing regions, who also fear the economic consequences of the ongoing transition. The policy's support for a broad range of renewables, rather than concentrating on the currently most cost-effective (and hence most mature)

technologies, has also been repeatedly criticized by the European Commission and others for being too costly. The entry of China in some segments of renewable energy technology, which to some extent has come at the expense of jobs in Europe, has also weakened the popularity of the policy in some circles. Thus, at the time of writing the support for the Energiewende from the political establishment in Germany appears to be dwindling (although polls shows it has been holding up well in the German population – see Lauber and Jacobsson 2015).

Sources: Lauber and Jacobsson 2015 and Bundesminister für Wirtschaft und Energie, <http://www.bmwi.de/DE/Themen/Energie/Energiedaten-und-analysen/Energiedaten/gesamtausgabe> , accessed on 17.03.2015

5. The governance challenge faced by Europe in arriving at policies for a sustainable future

In this section, we examine the governance challenge faced by Europe with regard to developing the necessary policies for economic recovery and confronting issues related to climate change and sustainability. These challenges are substantial and have become more daunting in recent years for a number of reasons, some of a general nature, others more specific to Europe.

The first has to do with the increasingly global nature of the problems confronting governments, requiring internationally coordinated, multilateral efforts to overcome them. Climate change is a prime example of that and the failure so far to come up with a comprehensive international agreement on how to deal climate change is, of course, very disappointing. Nevertheless, as pointed out by Laestadius (2015), there may be possibilities for international cooperation affecting climate change even in the absence of an effective global treaty, such as alliances of like-minded countries (with Europe taking the lead) pioneering new solutions and encouraging others to follow. There may also be possibilities for creating new forms of cooperation based on mutually recognized interdependencies, such as those between China and Europe in renewables (Schmitz and Lema 2015).

Secondly, not only are the political problems to be confronted today larger-scale, but they are also more likely to cross-cut organisational boundaries, particularly within governments (Bauer et al., 2012, pp.281-82). Challenges such as climate change or unemployment do not fit easily within a single ministry or department. Moreover, the problems tend to interact in an increasingly complex manner. For example, as noted above, policies to lower unemployment tend to lead to greater CO₂ emissions, unless carefully integrated with climate change policies. Energy policy, for instance, must give careful consideration to a range of issues including security (Geels 2015). Therefore, effective policies for transforming the economy towards

sustainability will most probably require the development of new forms of governance, characterized by a holistic perspective and by close coordination between different parts of government.

Thirdly, increasing globalization and the growing prominence of civil society have weakened the influence and power of the nation state (Holton, 1998; Pahl-Wostl, 2009). Over time, particularly in Europe, there has been a shift from dominance by national-level governments to multi-level governance (Hooghe and Marks, 2001) – local, regional, national, EU, and in some cases global. However, although this clearly adds to the complexity of governance (e.g. Bache, 2012), it also means that local and regional actors have much more space than before for pursuing their own strategies and forming alliances with others in similar situations, for instance, with respect to mitigating climate change (Geels 2015).

A fourth and closely related issue regards the increasing involvement of non-government actors, not least in Europe. The challenge associated with climate change illustrates the growing range of non-government actors that need to be involved in addressing the problem in order to ensure their commitment to the resulting policies and their implementation (Biermann, 2007, pp.332-33; Biermann & Pattberg, 2008, pp.280-282; Biermann & Gupta, 2011, p.1856; Bauer et al., 2012, pp.282-83). However, while making governance more complex, the involvement of non-governmental actors may also introduce a much needed new dynamics in policy-making, as evidenced, for example, by the German *Energiewende* (Lauber and Jacobsson 2015, see also Box 1) and the Norwegian policy on electric cars (Box 2).

Fifthly, there is a heightened sensitivity to risk and uncertainty . Technological advance and environmental change are areas beset by persistent uncertainty regarding their causes and their interactions, their impact and possible response options (Biermann, 2007, p.329). Risk and uncertainty naturally lead to advice advocating caution (with respect to nuclear energy, for example). However, the fundamentally uncertain nature of technological advance also means that policies for transformation should, as pointed out above, place an emphasis on pursuing a broad portfolio of different energy technologies and on not getting locked into a specific path of development that at one point may appear more cost-effective or promising.

A sixth factor adding to the governance challenges facing the EU is the growing number and diversity of Member States. . In the beginning, the European Economic Community consisted of just six members, each at a broadly similar level of development. Now, with 28 Member States and a number of other ‘neighbours’ who are aspiring members or otherwise subject to EU policy influence, those countries are quite different in terms of economic, industrial and institutional characteristics. It is no longer clear that policies based on the philosophy of ‘one size fits all’ are appropriate for the EU. On the contrary, policies that do not take Europe’s

heterogeneous character properly into account may well end up further aggravating the differences between countries rather than improving social cohesion.

Seventhly, and again a factor specific to the governance challenges faced by the EU, is the fact that the scale of resources at the disposal of the EU is in most cases very limited compared with those allocated by national governments (Begg 2015). For example, in the case of R&D and innovation, national government spending by Member States is typically an order of magnitude greater than that by the European Commission (as is spending by the private sector). The EU must, therefore, attempt to carefully 'leverage' its efforts, using its political authority to try to influence and coordinate national governments in a coherent and effective manner .

Lastly, the governance challenge and the task of arriving at a suitable policy response is made more difficult by a declining trust in (and diminishing popular support for) European institutions (Begg 2015). The spreading disillusion with the EU is to a large extent a consequence of the troubled economic circumstances and the apparent inability of EU policy-makers to do much to alleviate this. Hence, the failure of EU politicians in dealing effectively with the challenges that Europe faces is now coming back to haunt the entire European project. This clearly underscores the need for a new policy stance.

Recently, the governing bodies of the EU, in particular the European Commission and the European Central Bank, have started to devote more attention to the need to get Europe out of the present slump by increasing investments (European Commission, 2014) and adopting a more expansionary monetary policy. Although these initiatives are surely welcome, they will do little to stimulate the much needed European transformation towards sustainable growth (Laestadius 2015).⁹ The crucial question for policy, therefore, is how to get the European economy out of its present depressed state and simultaneously mobilize the European population in a collective innovation journey in the direction of a sustainable economy and society.

How innovation can best be stimulated, and what its social and economic effects are, has been the focus for researchers within the field of innovation studies for half a century or more.¹⁰ This research depicts innovation as a highly uncertain process responding to opportunities as they arise, be they in the form of new knowledge (which may make new products, services or ways of doing things possible) or related to emerging problems, needs and challenges (which require new solutions to be found). Innovation policy, therefore, is partly about supporting the development and spread of new knowledge that private sector firms would not develop with

⁹ For example, in a recent presentation of the EU investment plan, Vice-President Jyrki Katainen did not once mention climate change or sustainability (see "Vice-President Jyrki Katainen explains the EU investment plan", http://ec.europa.eu/priorities/jobs-growth-investment/plan/index_en.htm , accessed on 22 January 2015).

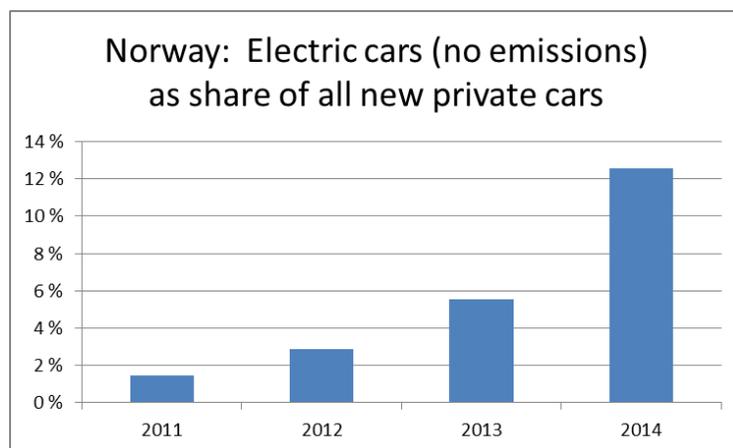
¹⁰ See Fagerberg (2004) and Martin (2012) for an overview.

their own money, but which nevertheless has the potential to spur subsequent innovation and economic growth (see Mazzucato and Perez 2015). However, creating demand for innovative new solutions may be equally or even more crucial because without demand innovative firms get nowhere (and are very likely to abandon their innovation efforts). As the Norwegian example of supporting the demand for electric cars shows (see Box 2), such policies can lead to surprisingly large changes during a relatively short time span. This matters because, in order to minimize the adverse consequence of climate change, the transformation process has to occur rather rapidly .

Box 2. Electric cars in Norway

During the last few years demand for electric cars has increased very rapidly in Norway. In 2014 one in eight new cars in Norway was electric (with no emissions). This is by far the highest share of any country. For example, the Norwegian share is three times higher than in the Netherlands, another important market for electric cars, and thirty times that of Germany. The rapid penetration of electric cars in Norway in recent years may be explained as the combined result of policies supporting their diffusion and technological progress which made electric cars more affordable and useful.

Already in the early 1990s environmental activists, reacting to local pollution problems in Norway's capital Oslo, managed to get accept for favourable conditions (e.g., taxes) for



electrical cars which at that time were extremely rare, expensive and with limited functionality . During the 2000s climate concerns became an additional argument for supporting electric cars. For a while Norway also had an indigenous electric car industry (e.g., "Think), which however struggled financially, was taken over by foreign owners and eventually closed down (just as

the market was beginning to pick up). Nevertheless, as part of a national compromise on climate policy, Norway's parliament decided in 2008 to continue to support the diffusion of electric cars at least until 2017 (or until the target of 50 000 electric cars on the roads was achieved) through continuing low or negligible taxes and other advantages (e.g., no road tolls,

access to bus lanes, free parking and charging of batteries), some of which were the results of local initiatives (in Oslo) that subsequently migrated into national policy.

Norway's policy for promoting diffusion of electrical cars was favourable for a long time, and increasingly so, with seemingly little effect. However, the decision to continue these policies for a number of years ahead (which together with Norway's high income levels made the country's market attractive for sellers of electric cars), came during a period when both new firms (e.g. Tesla) and incumbents in the car industry (such as Nissan) came up with new models with better functionality, broader customer appeal and – compared to their performance – lower costs than earlier generations of electric cars. The favourable policies meant that these models were also competitive in price compared with traditional cars with similar specifications, which together with other advantages for users, provided the basis for the surge in sales that followed.

Electric cars are particularly suited for urban areas and short distances. Norway is thinly populated, spanning long distances and, in addition, enduring harsh winters, all factors that are challenging for battery-driven cars. Arguably, if electric cars can make it there, they can make it anywhere, provided that suitable policies are in place.

Sources: IEA (2015), <http://www.ofvas.no/> (consulted on 12.03.2015) and Figenbaum and Kolbenstvedt (2013)

Moreover, policy makers can exert great influence on innovative activities by emphasizing the most pressing challenges or problems that need to be addressed. This type of innovation policy, which provides a sense of direction to the collective innovation journey and rallies potential contributors behind it, would be relevant for a wide range of activities essential for the transition to a sustainable economy, such as energy production, distribution and use, and also transport and construction. However, as pointed out above, in order to be effective, such a policy may have to link and coordinate different policy arenas (energy, transport, regional development, research, innovation etc.). Thus, sustainable growth requires more than technological innovation; new forms of governance are also required.

7 Conclusions

Europe (like many parts of the world but perhaps even more so) is confronted by an intimidating triple challenge – comprising economic stagnation, climate change, and a governance crisis. This paper demonstrates how these three challenges are closely inter-related. In particular, a return to economic growth cannot come at the expense of greater risk of irreversible climate change. Instead, what is required is a fundamental transformation of the economy to a new 'green' trajectory based on rapidly diminishing emission of greenhouse gases.

This entails developing strongly selective policies to promote the slumbering and hesitant investments in sustainable sectors and a much greater emphasis on innovation in all its forms (not just technological). Following this path would mean turning Europe into a veritable laboratory for sustainable growth, environmentally as well as socially. This is the direction that European policy-makers need to take.

This paper, amongst other things, has attempted to contribute to a broader understanding of what innovation is, how it may be encouraged and – most importantly – how it might help in addressing the triple challenge. Innovation is not primarily about scientific breakthroughs, although these are often very important, but more about continuous experimentation, learning, gradual improvements, cost reductions and increased performance of technologies that are already on the table. In the present case, that includes solar and wind power technologies, electric and hydrogen cars, heat-pumps and energy-saving along with exploiting the continuing ICT revolution and the new ways of life, work, transport and consumption that it makes possible. What is required for the transformation towards sustainability is not a new Manhattan program (Mowery et al. 2010) but rather to spur experimentation and learning on a broad front. Hence, what we need are policies that provide a clear and explicit sense of direction to this collective innovation journey, that support diffusion, learning and improvement of promising technologies, and that generate opportunities for entrepreneurial action (Mazzucato and Perez 2015).

The dominant policy approach to dealing with climate change in Europe up to now has tended to focus on getting "the prices right", with ETS as the central instrument. Yet this has proved far from successful. The reason is not that there is something wrong with the notion of getting "the prices right" (which would be wonderful if it worked) but it presupposes an all-powerful "social planner" who can decide on prices (through adjusting taxes, for instance). However, this is not how the European or the global political economy works. In the real world, there are many actors with different and often conflicting interests, and policy-makers are at best trying to manoeuvre between these while keeping certain long-term goals in mind. Therefore, acquiring the necessary momentum in the transformation process is critically dependent on mobilizing broad segments of society through advocating and experimenting with new solutions. It is very revealing in this respect that successful transformation policies, such as the German *Energiewende* and the Norwegian programme for electric cars, were not created through top-down initiatives by political leaders, but by pressure from green movements and environmental activists, which gradually received increasing support for these policies as they acquired momentum. However, this is an uphill struggle because as they gain momentum, such transformative policies also become more of a threat to established actors with strong interests in preserving the status quo.

Policies such as the Energiewende and the Norwegian electric car programme are examples of what economists often call "second best" policies, reserving the term "first best" for "getting the prices right". It is fallacious (even from an economic theory point of view) to criticize these policies on the argument that they are more expensive than "first best" policies when it is quite obviously an illusion that the latter may deliver the goods in time. Moreover, if combatting climate change requires a considerable amount of innovation, as almost everybody seems to agree, then it is not only the costs of particular policies that matter but also the effects on innovation. In this respect, a policy such as Energiewende is an inspiring example because it creates opportunities for experimenting, learning and innovation on a broad range of energy technologies, instead of becoming locked in to what observers at a certain point might see as the most 'cost-effective' approach. Incorrect assessments of this kind can have considerable costs. A century ago, electric cars were much more common than today (at least in terms of their share of the total car stock). That technological trajectory was then rejected in favour of the seemingly more cost-effective internal combustion engine driven by fossil fuels. But with hindsight, that assessment would now seem wrong because it did not take into account the detrimental consequences of petrol-driven cars for the climate. That illustrates the fundamental uncertainty associated with technological change and economic development, and might well have been impossible to foresee, but at least we now know enough to not make the same mistake again.

As pointed out earlier other parts of the world are also facing varying forms of the triple challenge, although the governance challenge may not be quite as severe as for the EU. Given the global character of the problem, and the many actors involved all round the world at different levels who may have a say in what happens, the ability to influence actors in other countries becomes of central importance. One key way to achieve this, and one for which Europe seems eminently well placed, would be to lead by example, providing solutions for how the climate challenge can be effectively dealt with. Taking the lead may, of course, incur significant costs; although the cost structure is far from obvious, doing nothing will undoubtedly have an impact in the years ahead in many areas of life. Conversely, Europe taking the lead in addressing the triple challenge may not only attract followers, thereby ensuring that climate change is kept within manageable bounds, but also lead to considerable benefits in the longer term in the form of strengthened industrial competitiveness, enhanced exports and new jobs. Moreover, addressing the triple challenge may provide Europe and its citizens with a new sense of purpose, revitalizing the EU, 'the European project' and Europe's role in the world over the decades to come.

References

- Abramovitz, M. (1986). 'Catching up, forging ahead, and falling behind', *Journal of Economic History*, 46: 386-406.
- Abramovitz, M. (1994a). 'The origins of the post-war catch-up and convergence boom', in J. Fagerberg, B. Verspagen, & N. von Tunzelmann (eds.), *The Dynamics of Technology, Trade and Growth*, Aldershot: Edward Elgar, 21-52.
- Abramovitz, M. (1994b). 'Catch-up and convergence in the post-war growth boom and after', in W.J. Baumol, R.R. Nelson & E.N. Wolf (eds.), *Convergence of Productivity – Cross-National Studies and Historical Evidence*, Oxford: Oxford University Press, 86-125.
- Bache, I. (2012). 'Multi-level governance in the European Union', in D. Levi-Faur (ed.), *The Oxford Handbook of Governance*, Oxford: Oxford University Press, 628-641.
- Bauer, A., Feichtinger, J. and Steurer, R. (2012). 'The governance of climate change adaptation in 10 OECD countries: challenges and approaches', *Journal of Environmental Policy & Planning*, 14: 279-304.
- Begg, I. (2015) EU Policy and Governance: Part of the Problem or Part of the Solution? In Fagerberg, J., S. Laestadius and B. R. Martin (2015) *The Triple Challenge for Europe Economic Development, Climate Change and Governance*, Oxford University Press, forthcoming
- Biermann, F. (2007). 'Earth system governance as a crosscutting theme of global change research', *Global Environmental Change*, 17: 326-337.
- Biermann, F. and Gupta, A. (2011). 'Accountability and legitimacy in earth system governance: a research framework', *Ecological Economics*, 70: 1856-1864.
- Biermann, F. and Pattberg, P. (2008). 'Global environmental governance: taking stock, moving forward', *Annual Review of Environmental Resources*, 33: 277-294.
- Cingano, F. (2014). 'Trends in income inequality and its impact on economic growth', OECD Social, Employment and Migration Working Papers, No. 163, Paris: OECD Publishing (downloaded from <http://dx.doi.org/10.1787/5jxrjncwvxv6j-en> on 7 January 2015).
- ECF (2013), *'From Roadmaps to Reality – A Framework for Power Sector Decarbonisation in Europe'*, Brussels: European Climate Foundation.
- European Commission (2014), *'An Investment Plan for Europe'*, Brussels: European Commission (downloaded from http://ec.europa.eu/priorities/jobs-growth-investment/plan/index_en.htm on 7 January 2015).

European Council (2014), 'Conclusions from the European Council 23 and 24 October 2014', EUCO 169/14, Brussels: European Council.

(<http://register.consilium.europa.eu/doc/srv?l=EN&f=ST%20169%202014%20INIT>)

European Council (2014), '*2030 Climate and Energy Policy Framework, Conclusion's*', EUCO 169/14, CO EUR 13 CONCL 5, Brussels 23-24 Oct. 2014

Fagerberg, J. (1994). 'Technology and international differences in growth rates', *Journal of Economic Literature*, 32: 1147-1175.

Fagerberg, J. (2004). 'Innovation: A guide to the Literature', in Fagerberg, J., Mowery, D., and Nelson, R (eds.) *The Oxford Handbook of Innovation*, Oxford: Oxford University Press, 2004, p 1-26.

Fagerberg, J., Feldman, M. and Srholec, M. (2014). 'Technological Dynamics and Social Capability: US and Europe', *Journal of Economic Geography*, 14 (2): 313-337.

Fagerberg, J. and B. Verspagen (2015) One Europe or Several? Causes and Consequences of the European Stagnation, in Fagerberg, J., S. Laestadius and B. R. Martin (2015) *The Triple Challenge for Europe Economic Development, Climate Change and Governance*, Oxford University Press, forthcoming

Figenbaum, E, and M. Kolbenstvedt (2013) *Electromobility in Norway - experiences and opportunities with Electric Vehicles*, Report 1281/2013, The Institute of Transport Economics , <https://www.toi.no/publikasjoner/elektromobilitet-i-norge-erfaringer-og-muligheter-med-elkjoretøy-article32103-8.html>

Geels, F. W. (2015) *The arduous transition to low-carbon energy: A multi-level analysis of renewable electricity niches and resilient regimes*, in Fagerberg, J., S. Laestadius and B. R. Martin (2015) *The Triple Challenge for Europe Economic Development, Climate Change and Governance*, Oxford University Press, forthcoming

Gerschenkron, A. (1962). *Economic Backwardness in Historical Perspective*, Cambridge, Mass.: Belknap Press.

Gordon, R. (2012). '*Is US Economic Growth Over? Faltering Innovation Confronts The Six Headwinds*', Working Paper 18315. Cambridge, Mass.: NBER.

Hooghe, L. and Marks, G. (2001). *Multi-level Governance and European Integration*, Lanham, MD: Rowman & Littlefield.

IEA (2011), '*World Energy Outlook 2011*', Paris: OECD/IEA.

IEA (2013a), '*Redrawing the Energy Climate Map*', Paris: OECD/IEA.

IEA (2013b), '*World Energy Outlook 2013*', Paris: OECD/IEA.

IEA (2014a), 'Key World Energy Statistics 2014', Paris: OECD/IEA.

IEA (2014b), 'World Energy Outlook 2014', Paris: OECD/IEA.

IEA (2015), Global EV Outlook 2015, http://www.iea.org/evi/Global-EV-Outlook-2015-Update_2page.pdf, accessed on March 12, 2015

IPCC (2012), 'Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation', Cambridge: Cambridge University Press.

IPCC (2013a), 'Climate Change 2013 – Mitigation of Climate Change', Cambridge: Cambridge University Press.

IPCC (2013b), 'Climate Change 2013 – the Physical Science Basis', Cambridge: Cambridge University Press.

IPCC (2014), 'Climate Change 2014 - Mitigation of Climate Change' (WGIII contribution to AR5). (www.mitigation2014.org).

Keller, W. (2004). 'International technology diffusion', *Journal of Economic Literature*, 42, 752-782.

Laestadius, S. (2015) Transition paths: assessing conditions and alternatives , in Fagerberg, J., S. Laestadius and B. R. Martin (2015) The Triple Challenge for Europe Economic Development, Climate Change and Governance, Oxford University Press, forthcoming

Landesmann, M. A. (2015)The new North-South Divide in Europe – Can the European Convergence Model be Resuscitated? In Fagerberg, J., S. Laestadius and B. R. Martin (2015) The Triple Challenge for Europe Economic Development, Climate Change and Governance, Oxford University Press, forthcoming

Lauber, V. and S. Jacobsson (2015) Lessons from Germany's Energiewende, in Fagerberg, J., S. Laestadius and B. R. Martin (2015) The Triple Challenge for Europe Economic Development, Climate Change and Governance, Oxford University Press, forthcoming

Long, ?? (2015) ...

Martin, B.R. (2012). 'The Evolution of Science Policy and Innovation Studies', *Research Policy*, 41: 1219-1239.

Mazzucato, M. and C. Perez (2015) Innovation as Growth Policy: the Challenge for Europe, in Fagerberg, J., S. Laestadius and B. R. Martin (2015) The Triple Challenge for Europe Economic Development, Climate Change and Governance, Oxford University Press, forthcoming

Mowery, D.C., R.R. Nelson and B.R. Martin (2010). 'Technology Policy and Global Warming: Why New Policy Models are Needed (Or Why Putting New Wine in Old Bottles Won't Work)', *Research Policy*, 39, pp.1011-1023.

Nordhaus, W. (2013). *The Climate Casino – Risk, Uncertainty and Economics for a Warming World*, New Haven & London: Yale University Press.

Pahl-Wostl, C. (2009). 'A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes', *Global Environmental Change*, 19: 354-365.

Piketty, T. (2014). *Capital in the Twenty-First Century*. Cambridge, Mass: The Belknap Press.

Schmitz, H. and R. Lema (2015) The Global Green Economy: Competition or Cooperation between Europe and China? In Fagerberg, J., S. Laestadius and B. R. Martin (2015) *The Triple Challenge for Europe Economic Development, Climate Change and Governance*, Oxford University Press, forthcoming

Smil, V. (2010), *Energy Transitions – History, Requirements Prospects*, Santa Barbara, California: Praeger.

Verspagen, B. (2004). 'Innovation and Economic Growth', in: Fagerberg, J., Mowery, D.C. and Nelson, R.R. (eds), *The Oxford Handbook of Innovation*, Oxford: Oxford University Press, p. 487-513

World Bank (2012), *'Turn Down the Heat – Why a 4°C Warmer World Must be Avoided'*, Washington, D.C.: World Bank.

World Bank (2013), *'Turn Down the Heat – Climate Extremes, Regional Impact, and the Case for Resilience'*, Washington, D.C.: World Bank.

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